Retrofit of a Waste-to-Energy Facility with a SCR System for NO_x and PCDD/PCDF Control, and a Na_2S_4 Injection System for Mercury Control

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A municipal waste-to-energy (WTE) facility located in North America has been in operation since 1992. The facility currently consists of a National Resource Technologies (NRT) fuel processing system followed by 4 Consumat type 110 TPD furnaces with heat recovery boilers and an evaporative cooling tower/dry lime injection/fabric filter based air pollution control (APC) system. The flue gases from the 4 furnace/boiler systems are collected in a common duct leading to the APC system. The APC system consists of two parallel APC trains that discharge through two induced draught (ID) fans into a single flue stack. Built to meet local emission standards, including < 20 mg/Rm^3 @ 11% O_2 particulate emissions and 0.5 ng TEQ/Rm^3 @ 11% O_2 PCDD/PCDF, the facility has operated at an average 91% availability since start-up while consistently meeting the emission standards during annual and semi-annual testing.

Having successfully demonstrated that the facility can operate and meet the existing environmental standards, the WTE facility is an important part of the waste management process in the local municipality. Rapid population increases in the local community brought increased pressures to look for ways to extend the life of the local landfill. While diversion activities were championed as one potential option, it was also recognized that additional benefits could be provided by both increasing the size of the facility and finding a use for the bottom ash so it could be diverted from the landfill. The facility examined bottom ash utilization opportunities and decided that processed material offered the highest potential for re-use. To that end, they developed a plan to process and dry the ash to achieve the greatest flexibility for re-use. Coupled with the need to provide heat to the drying process was an additional opportunity to generate electrical power using a gas-fired turbine/generating set. Waste heat from the turbine/generator exhaust could be used to dry the ash but only a limited amount could be used. Thus unique circumstances surrounded the evaluation of options for air emission control of the expanded facility.

Since the original facility was designed and commissioned, a ban on new WTE facilities was rescinded and the air emission standards were tightened. While existing facilities were exempted from tighter controls, expanding the facility triggered a need to comply with new standards that are equivalent to the U.S. EPA large facility standards promulgated in 1995. Essentially, mercury, cadmium, and lead along with PCDD/PCDF must be controlled to more stringent levels, and NO_x emissions must be reduced to 110 ppmv @ 11% O_2. While additional measures to control mercury and PCDD/PCDF emissions were available, the biggest technical challenge facing the owners was to find a reasonably priced system to reduce NO_x emissions.

Each of the two existing APC trains had been designed to accommodate the flue gases from three operating furnaces, therefore, no major changes were required to incorporate the new 5th furnace into the system. The project team considered various ways of achieving the desired improvement in APC performance and decided that SCR control offered the best chance of meeting the new NO_x emission standards. Taking advantage of the excess heat from the combustion turbine exhaust to reheat the flue gases to a SCR operating temperature of 255EC offered a lower capital cost than could be realized with heat exchanger equipped SCR systems. Moreover, utilizing the waste heat improve the heat rate of the turbine and provided better electrical energy pricing. The SCR was sized to control NO_x emissions from the combustion turbine and provide opportunities for the operator to select from a range of used turbines available in the market. The SCR application provides thermal catalytic oxidation of PCDD/PCDF allowing consideration of alternative mercury control measures.

An integrated approach covering all the aspects of the needed APC retrofit and facility expansion was chosen. A sodium-tetra-sulfide (Na_2S_4) injection system will be used to remove mercury from the WTE flue gas. This paper outlines the principle of this patented German technology, as well as the design of the injection system for the common duct leading to the existing APC system. By combining an SCR for NO_x control with a thermal oxidation step for PCDD/PCDF, the Combination SCR provides simultaneous removal of PCDD/PCDF and NO_x using the same catalyst within one reactor.

The paper will detail the process and reaction mechanisms of this European proven technology, as well as describing the design and set-up of the SCR reactor. The reactor will accept both the flue gas from the 5 furnaces, as well as that from the combustion turbine. The required NOx removal efficiency for the combined flue gas stream of over 70% and the required PCDD/PCDF reduction efficiency of about 90% can be assured by the catalytic reactions in the SCR reactor. NO_x is reduced to N_2 and H_2O in a reaction with ammonia while the PCDD/PCDF is thermally decomposed to its elemental constituents leaving no PCDD/PCDF contaminated residue. Parts of the flue gas exiting the SCR reactor will be utilized in the bottom ash dryer.

The paper presents the process technology and basic design of the system which, to the best of the authors' knowledge, will be the first SCR system retrofitted to a WTE facility in North America.